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A feasibility analysis of implementing interventions for discordant couples in 14 African countries: implications for epidemic control

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Abstract

We find interventions targeting serodiscordant couples (SDC) may not be feasible in countries where HIV prevalence is less than 5%, because only 3–19/1000 individuals are HIV-positive/negative and in SDC. Interventions may be feasible in countries where prevalence is greater than 10%, because 34–48/1000 individuals are HIV-positive/negative and in SDC. We calculated that 20–27% of all HIV-positive individuals, but less than 6% of all HIV-negative individuals, are in SDC. Consequently, targeting HIV-positive partners could significantly reduce transmission, whereas targeting HIV-negative partners may have little impact.

The WHO has recently recommended public health interventions targeted to discordant couples (i.e. couples wherein one partner is HIV-positive) should be a high priority [1]. Transmission in stable serodiscordant couples (SDC) can cause up to 50% of new HIV infections in Africa [2]. Two recent large-scale phase III clinical trials (HPTN 052 and the Partners PrEP Study) have shown interventions targeted to SDC can be extremely effective in reducing transmission [3,4]. HPTN 052 demonstrated providing antiretroviral treatment to the HIV-positive partner (i.e. using treatment as prevention, TasP) reduces transmission by 96% [3]. Partners PrEP Study demonstrated providing antiretroviral treatment to the HIV-negative partner (i.e. preexposure prophylaxis, PrEP) reduces transmission by 67–75% [4]. Now the efficacy of these interventions has been demonstrated, their feasibility needs to be evaluated. Here we present the first feasibility analysis of implementing public health interventions targeting SDC in sub-Saharan Africa. We assess the feasibility of implementing interventions based on TasP and PrEP.

We used data from 14 countries in sub-Saharan Africa: Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Malawi, Niger, Rwanda, Senegal, Tanzania and Zimbabwe. These countries show considerable variation in epidemic severity; HIV prevalence ranges from 1% (Niger, Senegal) to 24% (Lesotho). Discordancy levels range from 1% (Senegal) to 14% (Lesotho) [5]. Population size (15–49-year olds) ranges from 0.9 million (Lesotho) to 34.5 million (Ethiopia) [6]. By aggregating data from the 14

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countries, we determined whether HIV prevalence and the degree of discordancy are correlated. We then estimated, for each country, the number per 1000 individuals who are HIV-positive (or HIV-negative) and in SDC.

We used data for each country from their Demographic and Health Survey (DHS); these are nationally representative household surveys [7]. Data are collected on HIV prevalence, demographics, and the proportion of couples who are concordant positive (i.e. both individuals are HIV-positive), concordant negative (i.e. both individuals are HIV-negative) or discordant.

We aggregated DHS data from all 14 countries to determine the relationship between HIV prevalence and the level of discordancy; and the level of discordancy and positive concordancy. We then used country-specific DHS data to estimate the number per 1000 individuals who are HIV-positive and in SDC, in concordant couples or single. We made the same estimates for HIV-negative individuals. We used published methods and assumed 70% of the adult population were in couples [8,9].

We found [see Figure 1A in Supplementary Material (SM), <http://links.lww.com/QAD/A244>] an exponential function links HIV prevalence (y) and the level of discordancy (x):

$$y = A(e^{\alpha x} - 1) + \varepsilon, \quad (1)$$

where $\alpha = 0.13$ [95% confidence interval (CI): 0.10–0.17], $\hat{A} = 4.37$ (95% CI: 2.60–7.57), and ε is the error term. Consequently, if the prevalence is known for a specific country, the level of discordancy in that country can be estimated using the inverse function of equation (1):

$$x = \frac{1}{\alpha} \log \left(1 + \frac{y}{A} \right) \quad (2)$$

We also found, see Figure 1B in SM, <http://links.lww.com/QAD/A244>, an exponential function links positive concordancy and discordancy. This is specified by equation (1), but with the parameter values: $\alpha = 0.27$ (95% CI: 0.22–0.31) and $\hat{A} = 0.53$ (95% CI: 0.28–0.93).

The 14 countries can be classified into three categories based on prevalence. Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Niger, Rwanda and Senegal are low (<5%); Cameroon, Kenya and Tanzania are moderate (5–10%); Lesotho, Malawi and Zimbabwe are high (>10%). In high prevalence countries, 34–48 per 1000 individuals are HIV-positive and in SDC, 49–137 HIV-positive and in concordant couples, 41–52 HIV-positive and single (Table 1). The majority (40–58%) of all HIV-positive individuals in these countries are in concordant couples, 20–27% are in SDC and 22–33% are single. In moderate prevalence countries, 18–28 per 1000 individuals are HIV-positive and in SDC, 16–25 HIV-positive and in concordant couples, 16–21 HIV-positive and single (Table 1). In low prevalence countries, 3–19 per 1000 individuals are HIV-positive and in SDC, 1–12 HIV-positive and in concordant couples, 2–18 HIV-positive and single (Table 1).

Regardless of prevalence, the majority of HIV-negative individuals are in concordant partnerships or single (Table 1). In the 14 countries, 3–48 per 1000 individuals are HIV-negative and in SDC, 468–692 HIV-negative and in concordant couples, 248–296 HIV-negative and single (Table 1). Less than 6% of the HIV-negative individuals in the 14 countries are in SDC.

It is necessary to know both HIV prevalence and the level of discordancy to determine the feasibility of implementing interventions targeting SDC. However, in many countries, the level of discordancy in couples is unknown. Here we have identified a relationship between prevalence and discordancy. The statistical model (Equation 1) can now be used as a health policy tool to assess the feasibility of implementing interventions targeting SDC in countries where prevalence is known, but the level of discordancy is unknown.

Our findings have significant implications for global health policy. HPTN 052 and the Partners Study have shown TasP and PrEP can be extremely effective in reducing transmission within SDC. Here we have provided the first feasibility study of implementing these interventions. We calculated few (34–48/1000) individuals are HIV-positive (or HIV-negative) and in SDC, even when prevalence is more than 10%. Consequently, whether interventions use TasP or PrEP, they will be very challenging to implement even in high prevalence countries such as Lesotho, Malawi and Zimbabwe. Interventions targeting SDC in Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Niger, Rwanda and Senegal are unlikely to be feasible, because only 3–19 out of 1000 individuals are HIV-positive and in SDC in these low prevalence (<5%) countries.

In high (>10%) prevalence countries where it may be feasible to implement interventions targeting SDC, their impact on reducing transmission will depend upon the percentage of HIV-positive (for TasP) or HIV-negative (for PrEP) individuals who are in discordant couple. We have calculated that in Lesotho, Malawi and Zimbabwe, 20–27% of all HIV-positive, but less than 6% of all HIV-negative individuals, are in SDC. Consequently, using TasP for HIV-positive partners in these countries (if coverage is high [9]) could potentially significantly reduce transmission. However, providing PrEP to HIV-negative partners may have little impact on reducing transmission.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Modeling estimates for 14 countries in sub-Saharan Africa

Country	Population aged 15-19 (in millions)	HIV Prevalence (%)	Level of discordancy (%)	Number (per 1000) of HIV-positive individuals				Number (per 1000) of HIV-negative individuals			
				in SDC	in CC	Single	Total	in SDC	in CC	Single	Total
Lesotho	0.9	23.6	13.6	48	137	52	237	48	468	248	764
Zimbabwe	5.6	19.0	12.9	45	102	43	190	45	508	257	810
Malawi	6.2	12.5	9.7	34	49	41	124	34	582	259	875
Kenya	17.6	6.7	7.3	25	25	16	66	25	623	284	932
Tanzania	18.3	6.6	7.9	28	18	20	66	28	627	280	935
Cameroon	8.6	5.5	5.1	18	16	21	55	18	648	279	945
Côte D'Ivoire	10.1	4.6	5.5	19	8	18	45	19	653	282	954
Rwanda	4.5	3.1	2.2	8	12	12	32	8	673	288	969
Ghana	10.8	2.2	3.2	11	6	4	21	11	671	296	978
Ethiopia	34.5	2.1	1.7	6	2	13	21	6	686	287	979
Burkina Faso	6.5	1.9	2.6	9	3	7	19	9	678	293	980
Guinea	3.9	1.5	1.5	5	2	7	14	5	687	293	985
Senegal	5.5	0.8	0.8	3	3	2	8	3	691	298	992
Niger	5.3	0.8	0.9	3	1	4	8	3	692	296	991

Countries fall into three categories based on HIV prevalence: high ($>10\%$), moderate ($5-10\%$) and low ($<5\%$) prevalence. Modeling estimates are given for the number (per 1000) of HIV-positive and HIV-negative individuals who are in serodiscordant couples (SDC), concordant couples (CC), or not in couples (single). Calculations were based on the assumption that 70% of adults are in couples.